



## Radioactivity in the Risø District July-December 2011

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*Publication date:*  
2012

*Document Version*  
Publisher's PDF, also known as Version of record

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*Citation (APA):*  
Nielsen, S. P., Andersson, K. G., & Miller, A. (2012). *Radioactivity in the Risø District July-December 2011*. DTU Nutech. DTU-Nutech-R No. 1

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# Radioactivity in the Risø District July-December 2011

The cover design features a large rectangular area on the left with a grid of squares in shades of blue and green. A vertical red bar is positioned on the left side of this grid, containing the text 'DTU Nutech Report' in white. To the right of the grid is a solid light green rectangular area.

## DTU Nutech Report

Sven P. Nielsen, Kasper G. Andersson and Arne Miller  
DTU-Nutech-R-0001(EN)  
June 2012

**DTU Nutech**  
Center for Nuclear Technologies

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**Title:** Radioactivity in the Risø District July-December 2011  
**Division:** Radiation Research

**DTU-Nutech-R-0001(EN)**  
**June 2012**

**Abstract (max. 2000 char.):** The environmental surveillance of the Risø environment was continued in July - December 2011. The mean concentrations in air were:  $0.25 \pm 0.19 \mu\text{Bq m}^{-3}$  of  $^{137}\text{Cs}$ ,  $2.81 \pm 1.71 \text{ mBq m}^{-3}$  of  $^7\text{Be}$  and  $0.23 \pm 0.18 \text{ mBq m}^{-3}$  of  $^{210}\text{Pb}$  ( $\pm 1$  S.D.;  $N = 26$ ). The depositions by precipitation at Risø in the second half of 2010 were:  $0.102 \text{ Bq m}^{-2}$  of  $^{137}\text{Cs}$ ,  $757 \text{ Bq m}^{-2}$  of  $^7\text{Be}$ ,  $75.1 \text{ Bq m}^{-2}$  of  $^{210}\text{Pb}$  and  $< 0.8 \text{ kBq m}^{-2}$  of  $^3\text{H}$ . The average background dose rate (TLD) at Risø (Zone I) was  $67 \text{ nSv h}^{-1}$  compared with  $66 \pm 14 \text{ nSv h}^{-1}$  ( $\pm 1$  S.D.;  $N = 3$ ) in the four zones around Risø.

**ISBN: 978-87-995321-0-0**

**Contract no.:**

**Group's own reg. no.:**  
59514 E-1

**Sponsorship:**

**Cover :**

**Pages: 24**  
**Tables: 14**  
**References:**

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*Table 1. Radionuclides in ground level air collected at Risø (cf. Figs. 1, 1.1 and 1.2), July - December 2011. (Unit:  $\mu\text{Bq m}^{-3}$ )*

Date	$^7\text{Be}$	$^{137}\text{Cs}$	$^{210}\text{Pb}$
27-Jun-11 – 04-Jul-11	4385	0.462	259
04-Jul-11 – 11-Jul-11	3931	0.185	234
11-Jul-11 – 18-Jul-11	3057	0.165	122
18-Jul-11 – 25-Jul-11	1709	0.110	130
25-Jul-11 – 01-Aug-11	3031	0.319	214
01-Aug-11 – 08-Aug-11	9053	0.522	497
08-Aug-11 – 15-Aug-11	2336	0.102	95
15-Aug-11 – 23-Aug-11	3763	0.103	137
23-Aug-11 – 29-Aug-11	4450	0.205	289
29-Aug-11 – 05-Sep-11	4094	0.201	197
05-Sep-11 – 12-Sep-11	2546	0.062	95
12-Sep-11 – 19-Sep-11	3080	0.153	116
19-Sep-11 – 26-Sep-11	4787	0.172	267
26-Sep-11 – 03-Oct-11	2366	0.152	373
03-Oct-11 – 10-Oct-11	3016	0.161	196
10-Oct-11 – 17-Oct-11	1175	0.183	69
17-Oct-11 – 24-Oct-11	1613	0.156	138
24-Oct-11 – 31-Oct-11	2000	0.777	546
31-Oct-11 – 07-Nov-11	2159	0.495	799
07-Nov-11 – 14-Nov-11	1619	0.671	416
14-Nov-11 – 21-Nov-11	1963	0.459	294
21-Nov-11 – 28-Nov-11	1728	0.269	265
28-Nov-11 – 05-Dec-11	1545	0.129	56
05-Dec-11 – 12-Dec-11	1890	0.131	17
12-Dec-11 – 19-Dec-11	905	0.110	29
19-Dec-11 – 26-Dec-11	738	0.153	38
Mean	2805	0.254	226
SD	1705	0.190	182

Table 2.1. Radionuclides in precipitation in the 10 m<sup>2</sup> rain collector at Risø (cf. Fig. 1), July - December 2011. (Unit: Bq m<sup>-3</sup>)

Month	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
July	2076	0.506	210
August	2430	0.199	259
September	2175	0.193	255
October	1526	0.157	142
November	1673	0.154	109
December	1006	0.053	50

Table 2.2. Radionuclides in precipitation in the 10 m<sup>2</sup> rain collector at Risø (cf. Fig. 1), July - December 2011. (Unit: Bq m<sup>-2</sup>)

Month	Precipitation (m)	<sup>7</sup> Be	<sup>137</sup> Cs	<sup>210</sup> Pb
July	0.117	243	0.0592	24.6
August	0.112	272	0.0223	29.0
September	0.043	94	0.0083	11.0
October	0.039	60	0.0061	5.5
November	0.023	38	0.0035	2.5
December	0.050	50	0.0027	2.5
Sum	0.384	757	0.1021	75.1

*Table 2.3. Tritium in precipitation collected at Risø (cf. Figs. 1, 2.3.1 and 2.3.2). July - December 2011. (Unit: kBq m<sup>-3</sup>)*

Month	1 m <sup>2</sup> rain collector*	10 m <sup>2</sup> rain collector*
July	< 1.8	3.4
August	1.9	< 1.8
September	< 1.8	< 1.8
October	< 1.8	< 1.8
November	< 1.8	< 1.8
December	< 1.8	< 1.8
Double determinations*.		

*Table 2.4. Tritium in precipitation collected at Risø (cf. Fig. 1). July - December 2011. (Unit: kBq m<sup>-2</sup>)*

Month	Precipitation (m)	1 m <sup>2</sup> rain collector	10 m <sup>2</sup> rain collector
July	0.117	< 0.211	0.398
August	0.112	0.212	< 0.202
September	0.043	< 0.077	< 0.077
October	0.039	< 0.070	< 0.070
November	0.023	< 0.041	< 0.041
December	0.050	< 0.090	< 0.090
Sum	0.384	< 0.701	< 0.878



*Table 3.1. Radionuclides in sediment samples collected at Bolund in Roskilde Fjord.(cf. Fig. 3.1) July - December 2011. (Unit: Bq kg<sup>-1</sup> dry)*

Date	<sup>137</sup> Cs	K*
5 July	0.8	16.7
*Unit: g kg <sup>-1</sup> dry		

*Table 4.1. Radionuclides in seawater collected in Roskilde Fjord (cf. Fig. 4.1) July - December 2011. (Unit: Bq m<sup>-3</sup>)*

Date	<sup>137</sup> Cs
5 July	11.2

*Table 4.2. Tritium in seawater collected in Roskilde Fjord (Risø pier) (cf. Fig. 4.2) July - December 2011.*

Month	kBq m <sup>-3</sup>
July	< 1.8 *
August	< 1.8 *
September	1.8 *
October	2.1 *
November	< 1.8 *
December	< 1.8 *
* Double determinations	

*Table 5.1. Radionuclides in grass (\* snow) collected at Risø (near the Waste Treatment Station (cf. Fig. 1)), July - December 2011. (\*\*Measured on bulked ash samples)*

Week no. or month	Date	K (g kg <sup>-1</sup> fresh)	<sup>137</sup> Cs (Bq kg <sup>-1</sup> fresh)	<sup>137</sup> Cs (Bq m <sup>-2</sup> )
27	4 July	4.2	<0.4	
29	18 July	4.3	<0.5	
31	1 August	5.1	<0.4	
33	15 August	4.7	<0.5	
35	29 August	3.3	<0.4	
37	12 September	5.0	<0.3	
39	26 September	5.4	<0.5	
41	10 October	4.1	<0.5	
43	24 October	6.0	<0.6	
45	7 November	5.3	<0.3	
47	21 November	4.1	<0.4	
49	5 December	2.6	<0.3	
51	19 December	3.2	<0.3	
**July		4.3	0.042	0.025
**August		4.1	0.058	0.051
**September		5.7	0.029	0.017
**October		4.7	0.039	0.021
**November		5.0	0.046	0.019
**December		2.7	0.057	0.022

*Table 5.2. Radionuclides in Fucus vesiculosus collected at Bolund in Roskilde Fjord. July - December 2011. (Unit: Bq kg<sup>-1</sup> dry)*

Date	<sup>137</sup> Cs	K*	% dry matter
5 July	3.6	30	11
*Unit: g kg <sup>-1</sup> dry			

Table 7.1. Waste water collected at Risø (cf. Fig. 1), July - December 2011.

Week number	eqv. mg KCl l <sup>-1</sup>	<sup>137</sup> Cs (Bq m <sup>-3</sup> )	<sup>131</sup> I (Bq m <sup>-3</sup> )	<sup>226</sup> Ra (Bq m <sup>-3</sup> )
27	80	< 67	< 23	< 135
28	76	< 53	< 54	< 109
29	70	< 65	< 65	< 132
30	63	< 104	< 125	< 197
31	60	< 94	< 100	< 178
32	69	< 106	< 116	351
33	59	< 107	< 113	< 208
34	54	< 101	< 105	< 199
35	64	< 121	< 122	< 223
36	48	< 102	< 105	< 201
37	54	< 115	< 110	< 206
38	52	< 106	< 106	< 205
39	64	< 130	< 122	< 241
40	76	< 103	< 112	< 215
41	82	< 112	< 109	< 206
42	59	< 108	< 113	< 214
43	75	< 106	< 105	< 207
44	75	< 105	< 114	< 218
45	83	< 119	< 123	< 234
46	82	< 108	< 112	< 205
47	92	< 105	< 106	< 206
48	91	< 111	< 116	899
49	82	< 111	< 118	< 230
50	112	< 78	< 72	< 147
51	72	< 96	< 87	388
52	69	< 70	< 112	< 134
Mean	71.3			
SD	14.7			

*Table 8.1. Background dose rates around the border of Risø (cf. Fig. 8.1) measured with thermoluminescence dosimeters (TLD) in the period May 2010 – October 2011. (Results are normalized to  $\text{nSv h}^{-1}$ )*

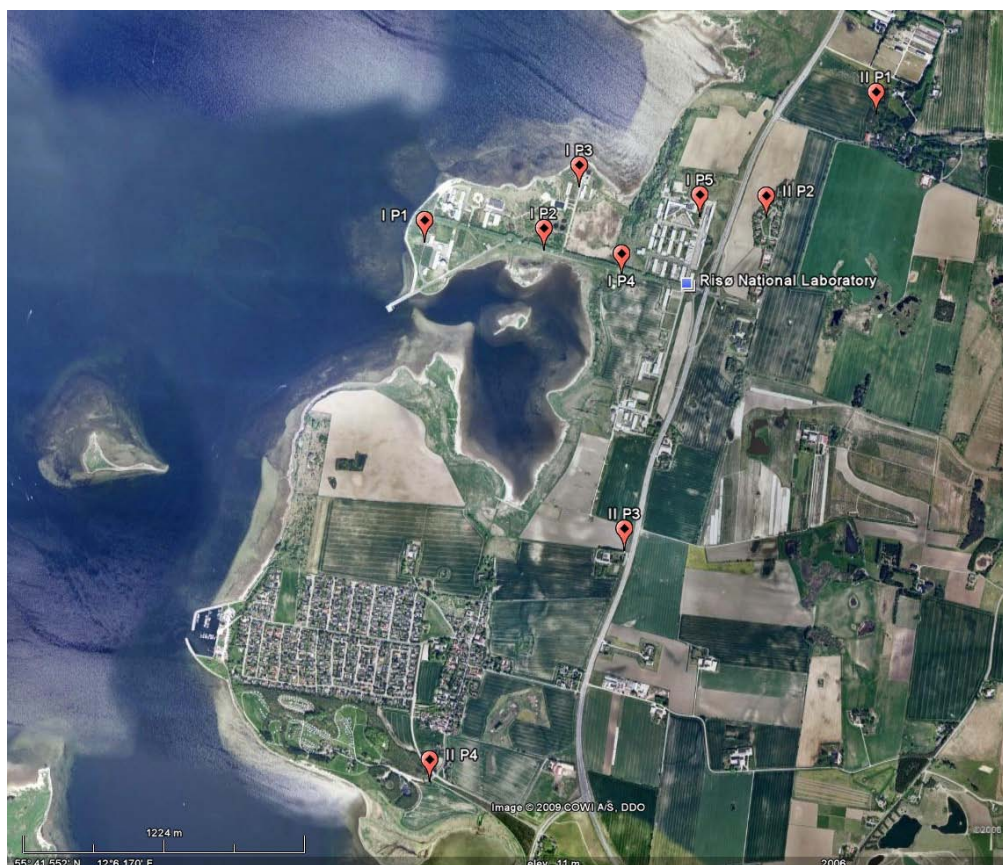
Location	$\text{nSv h}^{-1}$
1	67
2	56
3	52
4	69
5	60
6	62
Mean	64

*Table 8.2. Background dose rates around Risø (cf. Fig. 8.2 and Fig. 1) measured with thermoluminescence dosimeters (TLD) in the period May 2010 – October 2011. (Results are normalized to nSv h<sup>-1</sup>)*

Risø zone	Location	nSv h <sup>-1</sup>
I	1	39
I	2	55
I	3	93
I	4	70
I	5	80
Mean		67
II	P1	50
II	P2	72
II	P3	77
II	P4	-
Mean		66
III	P1	63
III	P2	64
III	P3	61
Mean		63
IV	P1	44
IV	P2	44
IV	P3	54
IV	P4	61
IV	P5	47
IV	P6	55
IV	P7	71
Mean		54
V	P1	75
V	P2	73
V	P3	75
V	P4	54
V	P5	73
V	P6	50
V	P7	69
V	P8	75
V	P9	79
V	P10	69
Mean		69

Table 8.3. Terrestrial dose rates at the Risø zones (cf. Fig. 8.2 and Fig. 1) July - December 2011. Measured with a NaI(Tl) detector. (Unit:  $\text{nSv h}^{-1}$ )

Risø zone	Location	July	October
I	P1	39	38
I	P2	43	49
I	P3	352	355
I	P4	41	42
I	P5	52	44
Mean		105	105
II	P1	50	46
II	P2	42	43
II	P3	38	43
II	P4	40	43
Mean		43	43
III	P1		46
III	P2		46
III	P3		44
Mean			46
IV	P1		43
IV	P2		48
IV	P3		44
IV	P4		43
IV	P5		43
IV	P6		44
IV	P7		46
Mean			44
V	P1		43
V	P2		51
V	P3		52
V	P4		47
V	P5		52
V	P6		49
V	P7		40
V	P7a		42
V	P8		48
V	P9		52
V	P10		42
Mean			47



*Fig. 1. Locations for measurements of gamma-background radiation Zone I and II (cf. Tables 8.2 and 8.3)*



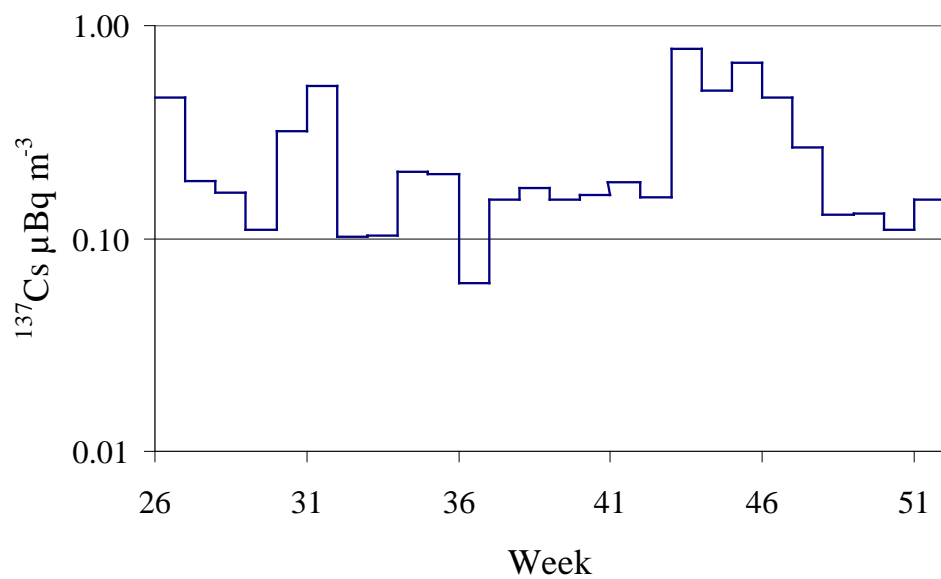


Fig. 1.1. Caesium-137 in ground level air collected at Risø in July-December 2011. (Unit:  $\mu\text{Bq m}^{-3}$ )

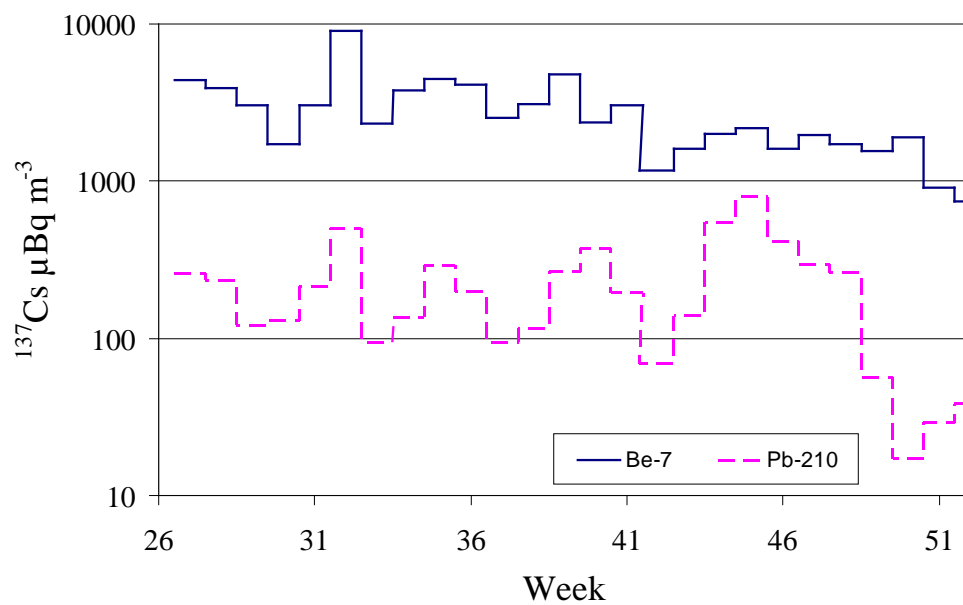


Fig. 1.2. Beryllium-7 and lead-210 in ground level air collected at Risø in July-December 2011. (Unit:  $\mu\text{Bq m}^{-3}$ )

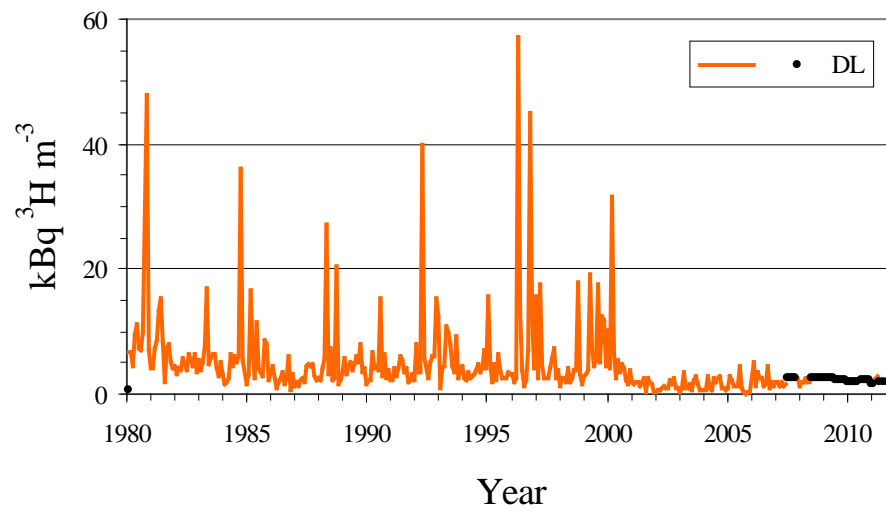


Fig. 2.3.1. Tritium in precipitation collected at Risø ( 1 m<sup>2</sup> rain collector ) 1980 - 2011. (Unit: kBq m<sup>-3</sup>; DL = detection limit )

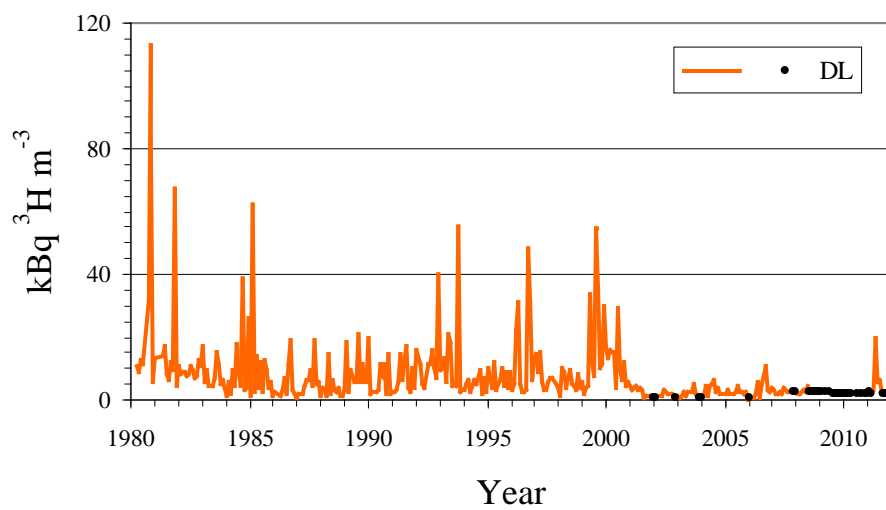
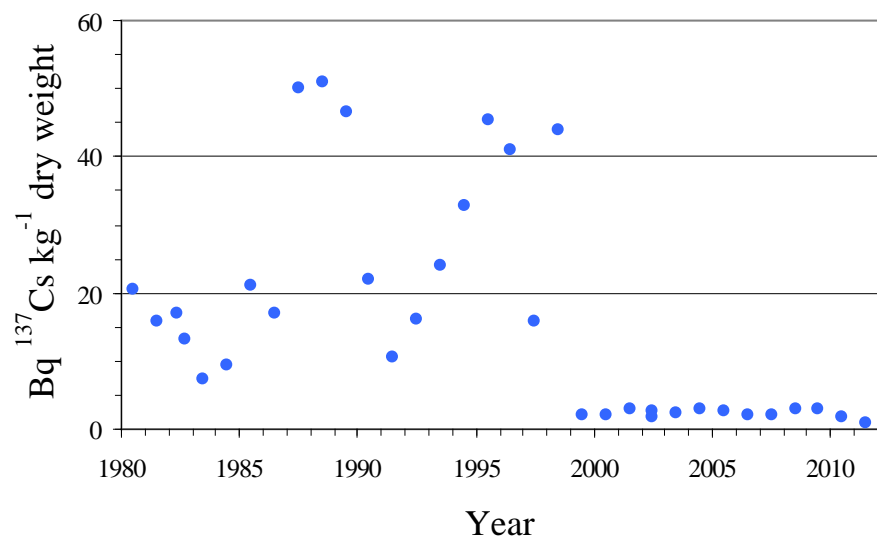


Fig. 2.3.2. Tritium in precipitation collected at Risø ( 10 m<sup>2</sup> rain collector ) 1980 - 2011. (Unit: kBq m<sup>-3</sup>; DL = detection limit )



*Fig. 3.1. Caesium-137 in sediment samples collected at Bolund in Roskilde Fjord. 1980 – 2011. (Unit: Bq kg<sup>-1</sup> dry matter)*

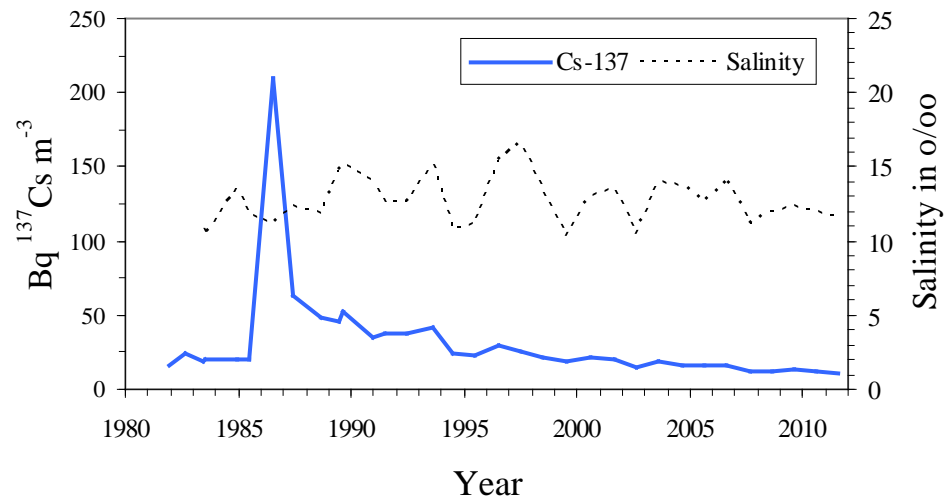


Fig. 4.1. Caesium-137 in seawater collected in Roskilde Fjord 1980 - 2011.  
(Unit:  $Bq\ m^{-3}$ )

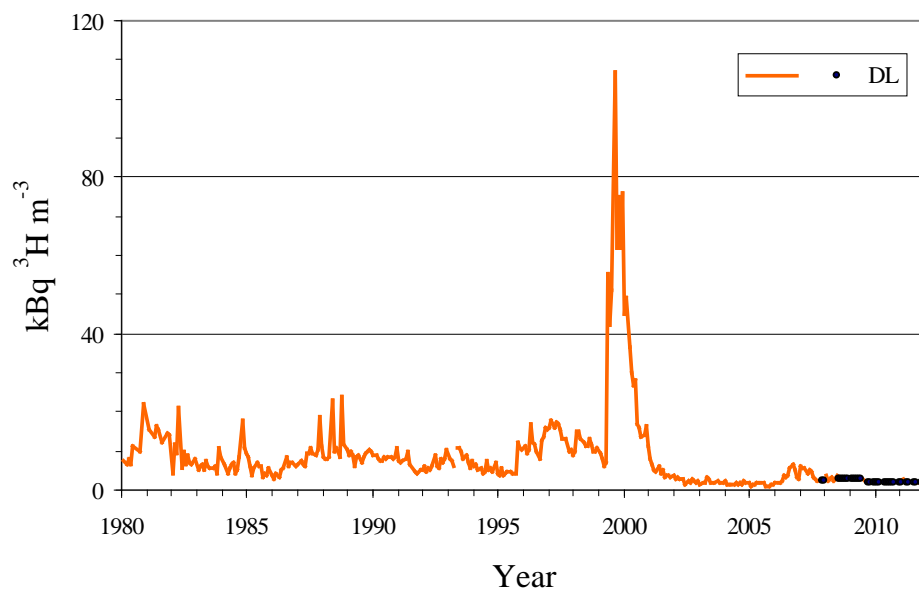
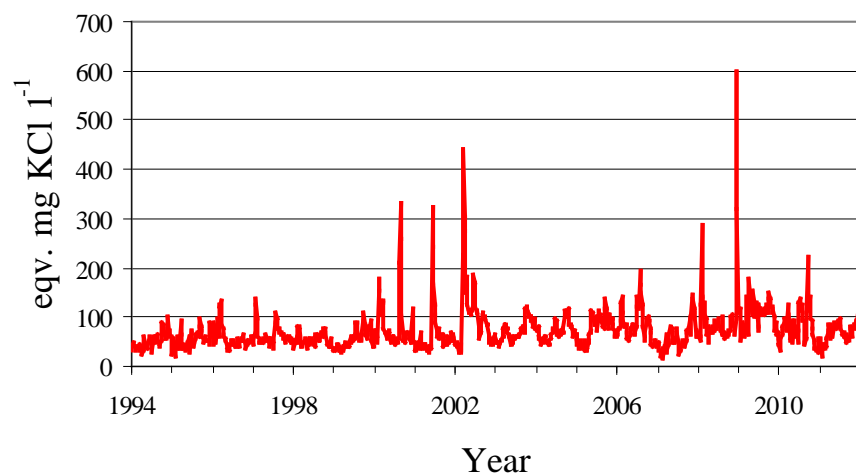
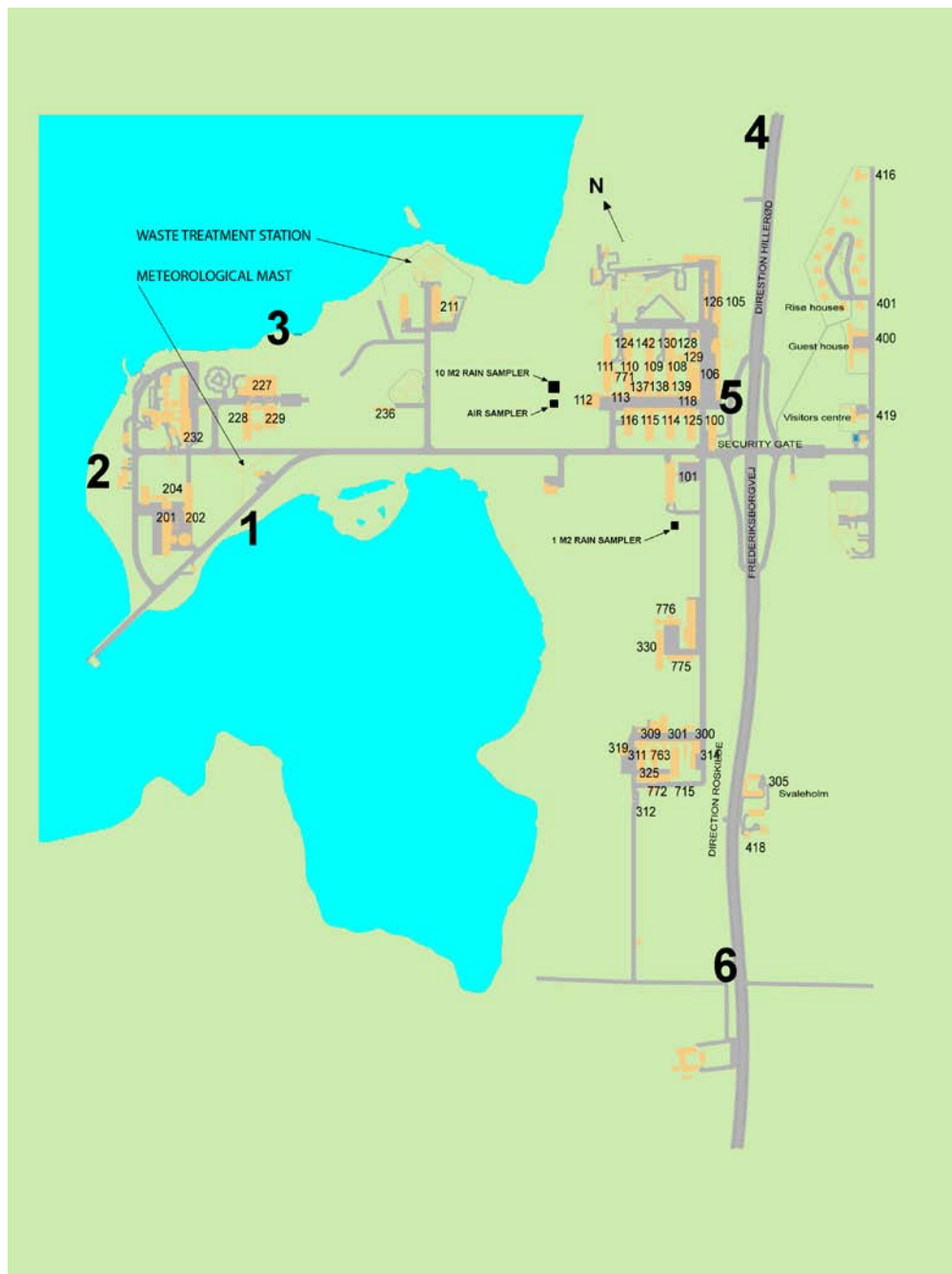


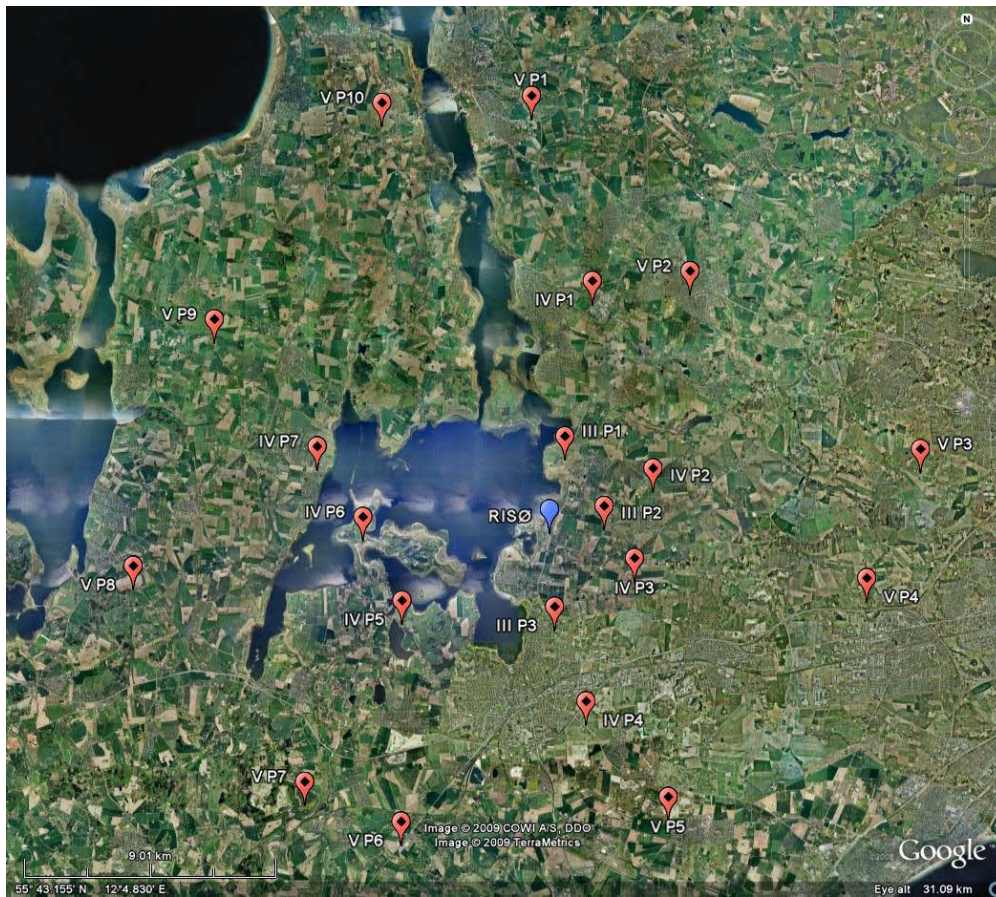
Fig. 4.2. Tritium in seawater collected in Roskilde Fjord 1980 - 2011.  
(Unit:  $kBq\ m^{-3}$ ; DL = detection limit)



*Fig. 7.1. Total-beta radioactivity in waste water collected at Risø 1994 - 2011.  
(Unit: eqv. mg KCl l<sup>-1</sup>)*



*Fig. 8.1. Locations (1-6) for TLD measurements around the border of Risø (cf. Table 8.1).*



*Fig. 8.2. Locations for measurements of background radiation around Risø in Zones III, IV and V.*





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